



Office de la propriété
intellectuelle
du Canada

Un organisme
d'Industrie Canada

Canadian
Intellectual Property
Office

An Agency of
Industry Canada

9

89/802,240



*Bureau canadien
des brevets*
Certification

La présente atteste que les documents
ci-joints, dont la liste figure ci-dessous,
sont des copies authentiques des docu-
ments déposés au Bureau des brevets.

*Canadian Patent
Office*
Certification

This is to certify that the documents
attached hereto and identified below are
true copies of the documents on file in
the Patent Office.

Specification and Drawings, as originally filed, with Application for Patent Serial No:
2,315,270, on August 4, 2000, by **CHARON SYSTEMS INC.**, assignee of Arron Fu,
Tamer Ahmed Afify, and William Martin Sloan, for "Printer Driver System for Remote
Printing".

Gracy Paushus
Agent certificateur/Certifying Officer

March 14, 2001

Date

Canada

(CIPQ 68)
01-12-00

OPIC  CIPO

SL2049

-17-

AbstractPrinter Driver System for Remote Printing

The present invention is concerned with providing a computer printer system which is particularly adapted for printing to a remote printer in a client-server environment. In the practise of the present invention, a universal printer driver is installed on the host server which creates a compressed, transmittable file that can be interpreted and printed by any printing device. This eliminates the need for a myriad of printer drivers being installed on the host server and increases speed and efficiency of print file processing by decreasing the need for bandwidth. The system results in faster, more convenient and more reliable printing to remote printers in a client-server arrangement.

Printer Driver System for Remote Printing

FIELD OF THE INVENTION

The present invention generally relates to a printer driver system, and more particularly, the invention relates to a printing process processed and executed on servers
5 in the client-server computer environment.

BACKGROUND OF THE INVENTION

In the client-server environment, the server operating system is called upon to handle communication interaction with a variety of client-based applications. The client operating system locates a server and requests a connection with the server and the server allocates
10 resources to handle requests from the client. This can include, for example, a print request to a designated printer connected locally or to the client.

Examples of such clients include workstations, desktop computers, laptops, hand held devices and the like. Examples of printer devices include laser printers, bubblejet printers, inkjet printers, multi-purpose machines which combine printing, faxing and/or
15 photocopying capabilities, and the like.

In some client-server systems, however, the client computer is a simple machine that is implemented with less functionality than a general-purpose computer. For instance, the client might be implemented as a terminal, which typically provides just enough
20 functionality to enable access to the server computer over a network. The terminal has no operating system or "intelligence"; rather, the operating system and applications reside at the server, and the processing takes place at the server.

More recently, low cost computers known as "network computers" or "NCs" have been introduced as a means for providing access to a network. Network computers have a display, a keyboard, a network port, and limited processing capabilities. Network

-2-

computers can provide some limited local processing, but are primarily reliant on the server for most processing. Presently available network computers are primarily configured to run applications written in Java, a language introduced by Sun Microsystems. Closely related to the NCs is another type of low cost computer, known as "Net PCs", which can run both Windows-based and Java-based applications, but which operate in a similar manner to an NC.

Various technologies, and in particular, a technology marketed under the name "MetaFrame" from Citrix Systems Inc., extend the typical Windows NT server operating system to support multiple client-server windowing sessions for connected clients, where each session provides a windowing environment for the connected client.

With the MetaFrame technology, for example, a client can connect to the Windows NT server and begin a windowing session. To the user, it appears as if the client is a standalone Window-enabled computer that is running its own Windows-brand operating system. However, the session is actually taking place on the server computer, remote from the client, and the client is merely running a local graphical user interface to provide entry to the session. In this regard, the MetaFrame technology is particularly well suited for low intelligent client computers, such as terminals and network-centric computers, because the client need not be capable of running its own operating system. However, the MetaFrame technology is also equally well suited for fully enabled clients.

A server operating system supports multiple client-server sessions and enables each client to work with applications hosted by the server and create and print work to local printers (connected to the server) or remote printers (connected to, for example, the client). It should be noted that an essential component of current client-server printer applications is that the host server must be able to support each of the numerous printers which might be selected. This is usually accomplished by installing the relevant printer driver on the host server.

However, issues evolving from the installation of printer drivers on the host server include the volume of printer devices on the market, the stability of the printer drivers for some devices, the reliability of the server after the installation of numerous printer drivers, and naming conventions of drivers among different operating systems.

A common problem with, for example, the Citrix MetaFrame technology, therefore, is the ability to print to any remote printer device. Another problem with Citrix

MetaFrame technology is the bandwidth usage taken by the server when processing a print job to a remote printer since bandwidth and speed are also issues that the host server must deal with when processing remote print jobs.

To exemplify the problem, consider a common scenario. A user logs onto the
5 Windows NT server from a client computer at the user's home. Connected to the user's computer is a multi-purpose printer/fax machine. The user works on a document using a word-processing software hosted by the server. The user then wants to print the work to the printer/fax machine connected to the home computer. The print job is processed by the server but it cannot be sent to the user's local printing device because the device is not
10 recognized or supported by the server's operating system or because the printing job requires more bandwidth than is available to send the print job across the connection.

The server must also recognize the type of printer/fax machine and send the print job to it in a recognizable form. The bandwidth available to the server-client must also be sufficient enough to allow for the speedy transfer of the file information.

15 A similar scenario would be a user that is connected to the host server through a terminal.

It should be noted that printers have their own "language". When work is sent to a printer, the content of the document is transformed to a format that a printer can recognize, interpret and print out. The most common formats are formats developed by
20 Hewlett Packard, Epson and PostScript. Conversion of the work to a printer format is generally accomplished by the use of a driver which driver is particular to an individual machine and operating system.

This means that for each printing device and operating system, a driver must be installed on the host server in order for it to process print jobs to that printing device. It
25 also means that the file created by the server and sent to the printer can vary in size depending on the type of printer. However, these printer files are typically quite large in nature, and thus generally require significant amounts of bandwidth in order to print at a reasonable speed. Also, due to their large size, the transmission speed of transferring the printer file from the server to the client's printer, can significantly affect the speed at
30 which the print job is completed.

Thus, in summary, a common problem in remote printing is that the printer file is large and, accordingly, requires a large bandwidth to transfer the print job. A second

-4-

problem is that the server must contain the printer driver files for all printers which may be connected to the computer systems of the remote user. A third problem is that the server must remain stable and reliable when dealing with a wide variety of different printer drivers.

- 5 While existing systems have met with some success, there is a desire to improve the printing system to better overcome these problems and to better focus on the needs of the user. In particular, there is a need to overcome these problems in order to reduce the bandwidth load, and to reduce the need for a large number of printer drivers to be stored on the host server.

10

SUMMARY OF THE INVENTION

Accordingly, it is a object of the present invention to provide a printer system which is able to reduce the number of printer drivers which must be stored on the server in a client-server environment.

- 15 It is a further object of the present invention to provide a printer system which is able to reduce the bandwidth necessary for transmission of a printer file from a server to a remote client printer in a client-server environment.

It is a further object of the present invention to provide a printer system which is generally more stable, and thus more reliable, than current printer systems in a client-server environment.

- 20 These and other objects are attained by providing a system wherein the host server has a universal printer driver that creates a compressed, transmittable printer file which can be used to print to a printer connected to the host server or the remote client printer.

- 25 Thus, the invention supports client-server printing by enabling a user to print to any printing device while connected to a host server without the need of having that device's driver installed on the host-server and without having to consider the client device. Furthermore, this can be achieved whether the user is accessing the server by a computer, hand held device, terminal or the like.

Accordingly, the present invention provides a computer printing system for a client-server computer system, comprising a host server, optionally connected to one or

more printers, and one or more remotely connected client computers, which are connected with one or more printers, wherein a universal printer driver is located on, or under the control of the host server, which universal printer driver, on receipt of a print request from a client computer, converts a non-universal print file to a compressed, transmittable file that is sent to, and which can be interpreted by a universal print file reader located on, a printer server system, so that a universal print file is transmitted, under the control of the host server, to at least one of said printers.

The system of the present invention thus negates or minimizes the need for a myriad of printer drivers being installed on the host server, and increases speed and efficiency of the print job processing by decreasing the need for bandwidth.

Preferably, the universal printer driver is installed on the host server, and a universal printer reader is installed on the client computer. When a user requests that work be printed, the host server processes the print request, creates a compressed, transmittable file, preferably sends the file to a printer server system, where it is interpreted by a universal print file reader and thus converted to a suitable printer file, and subsequently sent to the selected printer where it is printed. Thus, the host server generates a "universal print file" that can be interpreted by the universal print file reader.

A number of different universal printer drivers may be used to create a variety of compressed, transmittable files. These can include universal printer drivers which create files of the type commonly used with the file extensions of "tif" or "pdf", for example. Most preferred, however, are files of the type with the "pdf" extension created, for example by products such as Adobe Acrobat which is a commonly available product.

These types of files created with a universal printer driver, can be sent directly to the printer where they can be printed without any further modification, other than interpretation by the universal print file reader. This is in contrast to the situation where "pdf" or "tif" files (or more generally any universal print file) is printed from the Internet. In that case, the remote client computer is processing the information and print job. In the application of the present invention, the host server processes the information and print file on the remote client printer, with the client computer only acting to use the universal print file interpreter to generate the universal print file.

The host server and the client computer may be connected through a variety of means such as direct connections, wireless connections and the like. Preferably, the host server

-6-

and the client computer are connected as part of a networked computer system. Most preferably, the networked computer system is a Wide Area Network (WAN), a Local Area Network (LAN), an intranet or an Internet connection.

5 In a further aspect, the present invention also provides a method for printing in a client-server computer printing system having a host server, optionally connected to one or more printers, and one or more remotely connected client computers, which are connected with one or more printers, comprising,

requesting a print file from a host server by a client computer, to a printer server system,

10 translating the print file into a compressed, transmittable file using a universal printer driver located on, or under the control of the host server,

transmitting the compressed transmittable file to said printer server system,

translating the compressed transmittable file to a universal print file suitable for use by a printer connected to the printer server system by using a universal print file reader

15 located on said printer server system, and

transmitting said universal print file to at least one of said printers so that said print file is printed.

DETAILED DESCRIPTION OF THE INVENTION

20 As previously stated, a printer file is relatively large due to the fact that the content and the page format settings must be transmitted to the printer in a printer language understood by the printer. A key function of the universal printer driver is that it is able to compress the printer file into a smaller file which can be transmitted over the network connection (or Internet connections) more rapidly than the original, larger printer file.

25 Although any level of compression is generally of some assistance in increasing transmission speed and reducing bandwidth, it is preferred that the universal printer driver compress the printer file to a file size which is less than 95%, preferably 90%, and more preferably, 75% of its original size. Even more preferably, the universal printer driver will compress the printer file to a file size which is less than 50% of its original size.

-7-

The universal printer driver is preferably a commonly available program but may also be a proprietary program developed for this application. One commonly available program is available under the trade mark of Adobe Acrobat. Through Adobe Acrobat, a universal printer driver and a universal print file reader are available which can compress a printer file into a "pdf" printer format file for transmission across the network connection, and convert the "pdf" file into a file suitable for printing. The universal print file reader is generally a related product to the universal printer driver.

It should be noted that traditional printer drivers are generally dependent on the operating system under which the computer is operating. Thus, situations can occur wherein, for example, a host server running on Windows NT or Windows 2000 while the local remote client computer is running Windows 95 or 98, and the printer used on the client computer only has printer drivers for Windows 95 or 98. In this situation, even if the printer drivers are installed on the server, the server won't recognize them or support them. In this case, it can be difficult to manage to print to the remote client printer.

In contrast, a universal printer driver is typically one in which the driver is not dependent on the operating system, and can prepare a printer file which can be transmitted to any number of different operating systems.

Further, the universal printer driver can create a file which can be sent to a variety of machines such as computers running Windows operating systems, Apple computers, VAX computers, computers running under a UNIX operating system, thin-client configurations, Network PCs, NCs, PDAs and a variety of other client computer arrangements. Thus, the print driver is universal in that it creates a print file which can be used by almost all commonly available computer makes, models or operating systems.

The present invention is of use in any situation where a remote client is connected to a client-server arrangement. This includes various networked or Internet connections. Of most interest in the present invention however, is an application wherein the universal printer driver is installed on a server running Citrix MetaFrame. Accordingly, the host server may be any one of a variety of machines capable of acting as a server, but most preferably is a host server capable of running Citrix MetaFrame.

The printer server system generally will comprise a local remote computer which will be directly connected to the printer. However, the printer server system might also comprise a separate computerized system for converting the "pdf" file into a printer file

-8-

and then sending it directly to the printer without passing through the local, remote computer.

Similarly, the printer file generated by the host server may be converted to the compressed transmittable file in the host server directly. However, the printer file may be sent to a separate computerized system for conversion, before the compressed transmittable file is sent to the remote client computer.

The compressed transmittable file is normally sent directly to the printer server system directly. However, in an alternative embodiment, the compressed transmittable file may be sent to an electronic mail system of the host server, and sent to the client as an e-mail file. The e-mail file can then be printed as normal.

Other features of the present invention, as well as other objects and advantages attendant thereto, are set forth in the following description and the accompanying drawings in which like reference numerals depict like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the remote printer system of the present invention will now be described by reference to the following drawings wherein:

FIG. 1 is an illustration of a client-server computer system showing printing devices connected to the client computer;

FIG. 2 is a flow chart of a print job being processed on a client-server computer system according to the prior art;

FIG. 3 is a flow chart of a print file being processed on a client-server computer system according to the present invention;

FIG. 4 is a alternative arrangement for a client-server computer system according to the present invention; and

FIG. 5 is a further alternative arrangement for a client-server computer system according to the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Figure 1 is an illustration of a client-server computer system, generally depicted as 10, showing printing devices connected to the client computer. In particular, host server 12 is shown having three connection points, namely via a local area network (LAN) 14, via a wide area network (WAN) 15, or via the Internet 16. Connected to LAN network 14 are a plurality of client computers, of which two are shown, namely a desktop PC 20, a laptop PC 30. Each client computer has an attached printer designated as 21 and 31.

Two "thin client" access terminals, generally designated as 42, and a print server 40, are shown as being connected to WAN network 15. Connected to print server 40 are two printers generally designated as 41.

Connected to Internet 16 are a plurality of client computers, of which two are shown, namely a handheld PC 50 (such as a PDA (personal digital assistant) including those sold under the trade name PalmPilot, or e-mail tools such as BlackBerry, or other devices running under Windows CE) and a remote client PC 60. Connected to the client computer systems are printers 51 and 61.

Although variations are possible, this represents a standard configuration for a client-server computer arrangement, and in particular, for a client-server computer arrangement wherein the host server is running a program such as Citrix MetaFrame wherein the remote PC, or the like, is used merely as a terminal to access and use various programs on the host server, and where the host server is used for processing various functions in place of the remote PC.

In Figure 2, a flow chart of a print job being processed on a client-server computer system of Figure 1, according to the prior art, is shown. In this example, the user of desktop PC 20 wishes to print a document to PC 21, the flow chart of the actions taken would be as shown in Figure 2. Initially, the user makes a request for a file to be printed and requests that the file be printed to printer 21. The file is a 15 page document with text and graphics with a size of 142 KB. Server 12 receives the print request, identifies printer 21 and locates the correct driver for printer 21. If the server fails to find the correct driver for the printer, then the print job is abandoned. Only if the correct driver is found, is the print job continued. Using the correct driver, host server 12 prepares a printer file which

-10-

is then sent to PC 20 over the network connection 14. The printer file for the 15 page document is now 6287 KB in size, and thus creates a large file to be transferred to PC 20. The printer file is then forwarded to printer 21 from PC 20 where it is printed.

5 In this example, a relatively large printer file is prepared assuming that printer 21 is a printer which is supported by host server 12, and assuming that host server 12 has the correct driver for printer 21. If the printer is not supported and/or the host server does not have the correct driver, then the print request will fail.

10 In Figure 3 a similar flow chart is shown of a print file being processed on a client-server computer system according to the present invention. Using the same desktop computer 20, the user makes a request for a file to be printed. Host server 12 receives the print request and uses a universal printer driver to prepare a universal print file for transmission to PC 20 over network connection 14. In this case, the universal printer driver creates a compressed, transmittable printer file having a "pdf" format. The universal print file for the same 15 page document is now 68 KB in size, and takes far less time to be transferred to PC 20. Once the universal print file is received, the user at PC 20 can optionally preview the document and can select the desired printer. The universal printer file reader will then interpret the universal print file, and PC 20 will then forward the universal print file to printer 21 where it is printed.

20 As is seen, using this approach results in a much smaller file being transferred over network 14, so that the time for transfer is reduced. Also, the host server 12 no longer needs to identify or support printer 21, and does not even need to know which type of printer is to be selected. Host server 12 now merely uses the universal printer driver to create a universal print file. Accordingly, the number of printer drivers stored on the host server 12 is greatly reduced. The remote PC 20 is now used to merely forward the universal print file to the printer 21.

Similar flow charts would be used for any of the remote PC systems shown in Figure 1, namely PCs 30, 40, 50 and 60, whether connected through the LAN 14, the WAN 15 or the Internet 16, when printing on printers 31, 41, 51, and 61 respectively.

30 In Figure 4 an alternative arrangement for a client-server computer system according to the present invention is shown. In Figure 4, a host server 112 is connected via a LAN 114 to a number of thin client terminals, generally designated as 142. Connected to LAN 114 is a printer server 140, to which is connected printer 141. Also connected to LAN

-11-

114 is a WAN 118 to which is connected a series of thin client terminals, of which two are shown, and generally designated as 132. Also connected to WAN 118 is a printer server 130 to which is connected printer 131.

In this embodiment, when a user on a thin client terminal (either 132 or 142) makes a
5 print request, the request is sent to host server 112. Host server 112 uses a universal printer driver to prepare a universal print file. Depending on the printer selected, the universal print file is forwarded to either printer server 130 or printer server 140, from which the universal print file is forwarded to printer 131 or 141 where the file is printed.

Again, in this embodiment, a smaller, compressed universal print file is transmitted
10 over the LAN or WAN rather than the larger printer file. Also, the host server does not need to support the remote printers or have the printer drivers for all of the remote printers which might be used.

Also, it should be noted that it is not necessary for the user's computer to be attached to dedicated printer PC 140. This can be of convenience if the user's computer is a laptop
15 or a hand held PDA, for example, and thus might be removed from its normal printer connection. Additionally, this would allow a wireless connection to the Internet to be used from a mobile PC or PDA which would still allow for printing at a remote printer.

In Figure 5 a further alternative arrangement for a client-server computer system according to the present invention is shown. This arrangement includes an e-mail server
20 219 connected to host server 212 through a network 214.

In this embodiment, a print request to the host server 212 from a remote user on PC 220 is received through network 214. In this example, however, the "print job" is to be sent as an e-mail attachment. Host server 212 uses a universal printer driver to create a universal print file with a "pdf" format which is sent through network 214 to e-mail server
25 219. E-mail server 219 creates an e-mail message 217 which is sent via the Internet 216 to PC 220, where it is received and stored. The universal print file can then be printed at any convenient time on printer 221.

In this fashion, a standard e-mail message can be sent to any party selected by the user, and not just by the user of PC 220, for them to print a universally accepted file on
30 their own printers.

SL2049

-12-

Thus, it is apparent that there has been provided, in accordance with the present invention, a printer driver system which fully satisfies the means, objects, and advantages set forth hereinbefore. Therefore, having described specific embodiments of the present invention, it will be understood that alternatives, modifications and variations thereof may
5 be suggested to those skilled in the art, and that it is intended that the present specification embrace all such alternatives, modifications and variations as fall within the scope of the appended claims.

Additionally, for clarity and unless otherwise stated, the word "comprise" and variations of the word such as "comprising" and "comprises", when used in the
10 description and claims of the present specification, is not intended to exclude other additives, components, integers or steps.

-13-

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A computer printing system for a client-server computer system, comprising a host server, optionally connected to one or more printers, and one or more remotely
5 connected client computers, which are connected with one or more printers, wherein a universal printer driver is located on, or under the control of the host server, which universal printer driver, on receipt of a print request from a client computer, converts a non-universal print file to a compressed, transmittable file that is sent to, and which can be interpreted by a universal print file reader located on, a printer server system, so that
10 a universal print file is transmitted, under the control of the host server, to at least one of said printers.
2. A computer printing system as claimed in Claim 1 wherein said printer server system is the client computer and a printer connected to, or under the control of the client computer.
- 15 3. A computer printing system as claimed in Claim 1 wherein said universal printer driver is installed on the host server, and said universal printer reader is installed on the client computer.
4. A computer printing system as claimed in Claim 1 wherein the universal printer driver is able to compress the printer file into a smaller file which can be
20 transmitted more rapidly than the original, larger printer file.
5. A computer printing system as claimed in Claim 4 wherein the universal printer driver compresses the printer file to a file size which is less than 90% of its original size.
- 25 6. A computer printing system as claimed in Claim 4 wherein the universal printer driver compresses the printer file to a file size which is less than 75% of its original size.

-14-

7. A computer printing system as claimed in Claim 4 wherein the universal printer driver compresses the printer file to a file size which is less than 50% of its original size.

8. A computer printing system as claimed in Claim 1 wherein the universal printer driver is one in which the driver is not dependent on the operating system, and can prepare a print file which can be transmitted to any number of different operating systems.

9. A computer printing system as claimed in Claim 1 wherein the universal printer driver can create a print file which can be sent to a variety of machines including computers running Windows operating systems, Apple computers, VAX computers, computers running under a UNIX operating system, thin-client configurations, Network PCs, NCs, and PDAs.

10. A computer printing system as claimed in Claim 1 wherein said universal printer drivers creates files of the type commonly used with the file extensions of "tif" or "pdf".

11. A computer printing system as claimed in Claim 1 wherein said universal printer driver creates files of the type commonly used with the file extension "pdf".

12. A computer printing system as claimed in Claim 1 wherein the universal printer driver is installed on a server running Citrix MetaFrame.

13. A computer printing system as claimed in Claim 1 wherein said host server is a host server capable of running Citrix MetaFrame.

14. A computer printing system as claimed in Claim 1 wherein the host server and the client computer may be connected through direct connections or by wireless connections.

-15-

15. A computer printing system as claimed in Claim 1 wherein the host server and the client computer are connected as part of a networked computer system.

16. A computer printing system as claimed in Claim 1 wherein the networked computer system comprises a WAN, a LAN, an intranet or Internet connection.

5 17. A computer printing system as claimed in Claim 1 wherein the printer server system comprises a separate, dedicated PC for forwarding the universal print file directly to the printer without passing through the local, remote computer.

18. A computer printing system as claimed in Claim 1 wherein the printer file is sent from the host server to a separate computerized system for conversion to a
10 compressed, transmittable file, before the compressed transmittable file is sent to the remote client computer.

19. A computer printing system as claimed in Claim 1 wherein the compressed transmittable file is sent to an electronic mail system of the host server, and sent to the client as an e-mail file.

15 20. A method for printing in a client-server computer printing system having a host server, optionally connected to one or more printers, and one or more remotely connected client computers, which are connected with one or more printers, comprising,
requesting a print file from a host server by a client computer, to a printer server system,
20 translating the print file into a compressed, transmittable file using a universal printer driver located on, or under the control of the host server,
transmitting the compressed transmittable file to said printer server system,
translating the compressed transmittable file to a universal print file suitable for use
by a printer connected to the printer server system by using a universal print file reader
25 located on said printer server system, and
transmitting said universal print file to at least one of said printers so that said print file is printed.

SL2049

-16-

21. A method as claimed in Claim 20 wherein said printer server system is the client computer and a printer connected to, or under the control of the client computer.

22. A method as claimed in Claim 20 wherein said universal printer driver creates files of the type commonly used with the file extensions of "tif" or "pdf".

5 23. A method as claimed in Claim 20 wherein said universal printer driver creates files of the type commonly used with the file extension "pdf".

24. A method as claimed in Claim 20 wherein the universal printer driver is installed on a server running Citrix MetaFrame.

10 25. A method as claimed in Claim 20 wherein said host server is a host server capable of running Citrix MetaFrame.

26. A method as claimed in Claim 20 wherein the host server and the client computer may be connected through direct connections or by wireless connections.

27. A method as claimed in Claim 20 wherein the host server and the client computer are connected as part of a networked computer system.

15 28. A method as claimed in Claim 20 wherein the networked computer system comprises an intranet or Internet connection.

Fig 1.

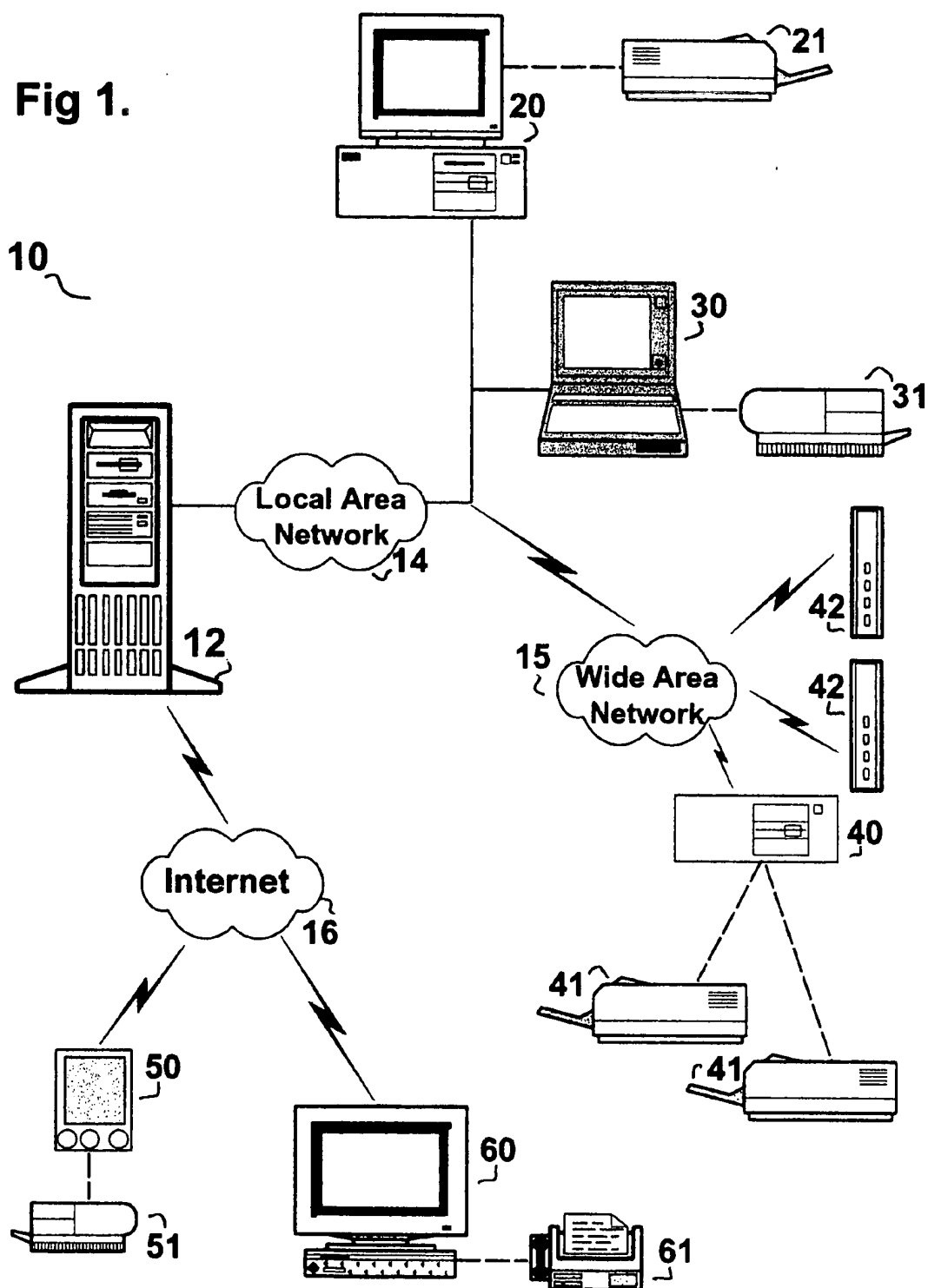
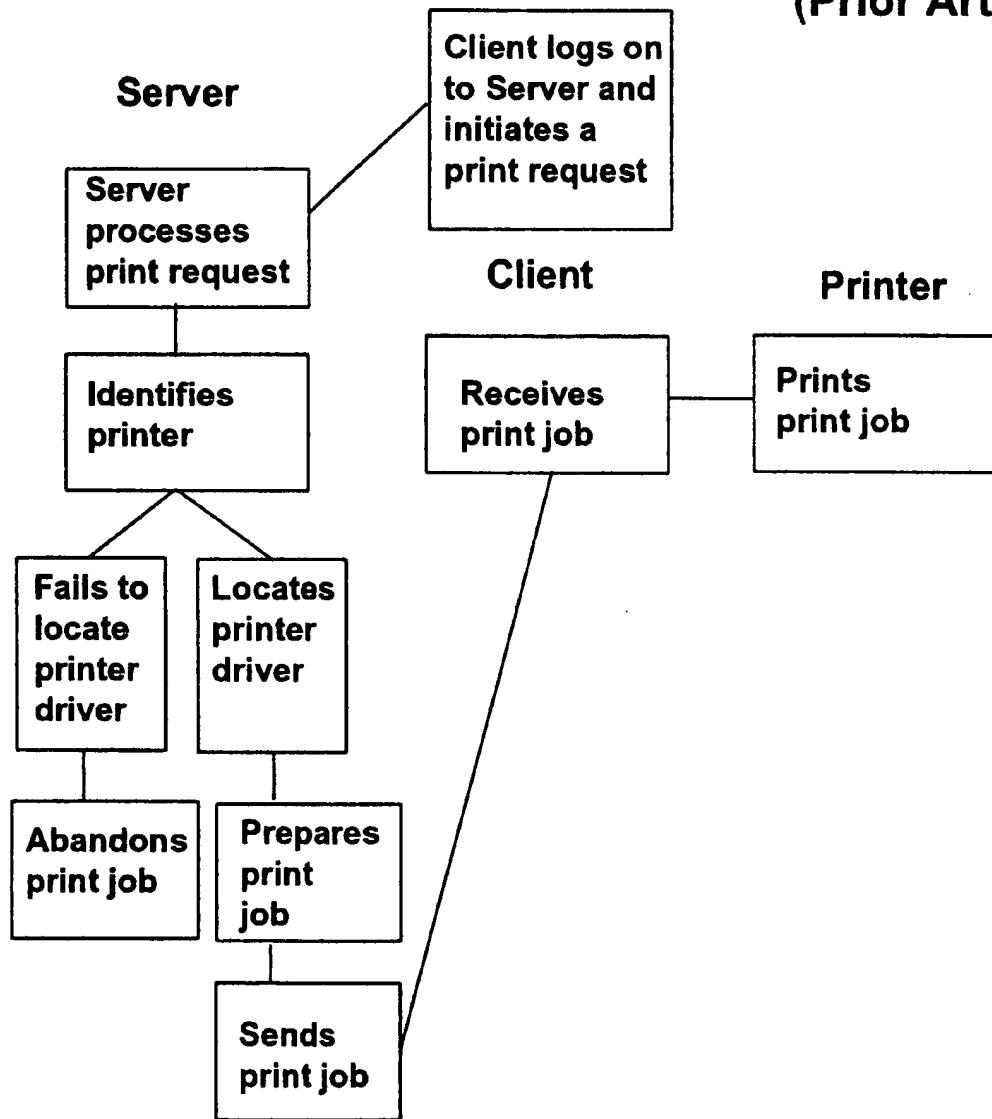
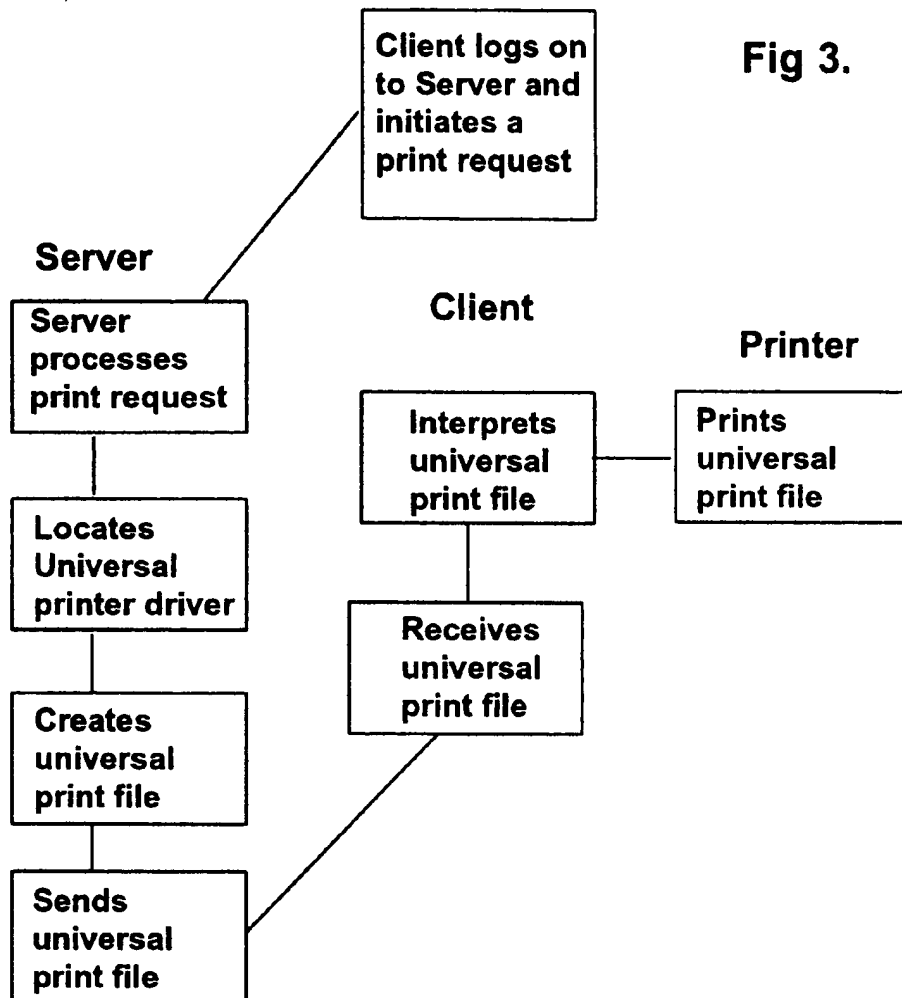


Fig 2.
(Prior Art)





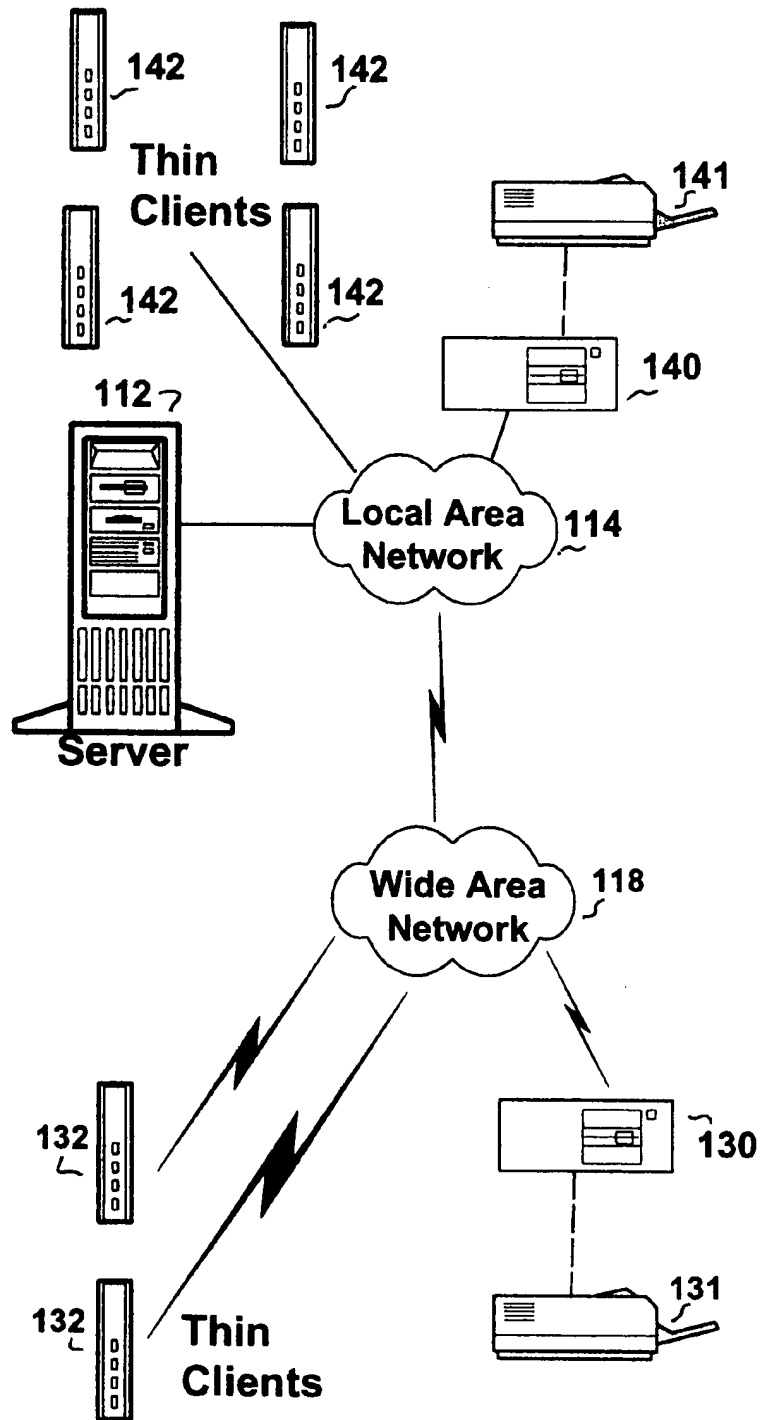


Fig 4.

Fig 5.

